Vertebrate wildlife incidents with pesticides: a European survey

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Abstract: A survey was carried out to investigate terrestrial wildlife incidents with pesticides in 18 European countries over the period 1990–1994. Only in seven countries does a systematic incident registration system exist. Compared with the other countries, relatively high numbers of incidents were registered in France, the Netherlands and the United Kingdom. Over 1000 incidents were investigated to establish their causes: approved use, misuse or deliberate abuse, and the compounds, species and mode of application involved. It was found that most registered incidents are due to deliberate abuse. Approved use is responsible for only a minor fraction of the incidents, and these are due to particular practices such as use of treated seed, bait or wood preservatives and the spraying of grassland. Hardly any incidents were due to crop-spraying. The reason why so few incidents are registered for normal crop-spraying is discussed: do they not occur, or are the casualties not registered? It is doubtful whether incident registration is a reliable instrument for obtaining a proper understanding of the occurrence of the side-effects of agricultural pesticide use.

Keywords: pesticide; wildlife incident; vertebrate poisoning

1 INTRODUCTION

Wildlife incidents caused by pesticides have been reported ever since man started using these chemicals. As to the reasons for such incidents, several categories can be distinguished.[1] Incidents may be due to:

- approved use, whereby a pesticide is applied according to the specified conditions for its use;
- misuse, whereby a pesticide is not applied according to the specified conditions for use (incidents due to careless, accidental or wilful failure to adhere to the correct practice);
- deliberate abuse, whereby a pesticide is used in a deliberate, illegal attempt to poison animals.

The results of the Wildlife Incident Investigation Scheme in the UK[1] indicate that even today a substantial number of terrestrial vertebrates are killed by pesticides each year. In other European countries there is little if any understanding of the nature and scale of such incidents, however. The aim of this study is to give an overview of the extent to which pesticide-related incidents involving terrestrial vertebrates still occurs and the causes of such incidents. Incidents involving farm livestock and companion animals (cats and dogs) were excluded from the study.

The study focused on four main questions:

- to what extent are wildlife incidents with pesticides registered in Europe?
- how frequently do incidents occur in the different countries of Europe?
- what are the reasons for these incidents: approved use, misuse or deliberate abuse?
- what substances, mode of use and animal species do the incidents involve?

The study was conducted at the Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment, where work is in progress on designing a safety net for pesticide development and use. In this context post-registration monitoring of incidents might serve as one possible instrument for generating feedback to approval and application criteria.

2 METHODS

In order to obtain a better understanding of the nature and scale of pesticide incidents involving terrestrial vertebrates, a survey was conducted of incidents taking place in the period 1990–1994 in 18 European countries: Austria, Belgium, Denmark, France, Germany, the United Kingdom, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden and Switzerland. First, the embassies of these countries in the Netherlands, and Dutch embassies abroad, were asked whether such incidents are indeed registered, and if so, where. The respective research institutes, conservation organisations and ministries identified

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Table 1. Total number of pesticide incidents in individual European countries (1990–1994)

Country	Total[a]	Birds	Mammals	Amphibians
France	414	276	140	0
United Kingdom	384	311	103	1
Netherlands	221	216	8	0
Germany	14	13	0	1
Denmark	13	13	0	0
North Greece	11	11	0	0
Norway	6	6	0	0

[a] Total number of incidents may be less than sum of individual groups, because of different groups being involved in the same incident; for France, double-counting in total number of incidents cannot be entirely excluded, so that actual total may be slightly lower.

were then contacted. A total of 103 institutions were approached with a request for information and, of these, 47% responded. As a follow-up, in the Netherlands and France the institute responsible for incident registration was visited. The study also made use of published resources.[1–14] In connection with statistical processing, it should be noted that the information on incidents in France relates to the years 1994 and 1995. In the United Kingdom data for 1990 and 1991 do not include Northern Ireland.

3 RESULTS

First, the incident registration scheme in place in the various countries is discussed. No information was received from Austria, Hungary, Italy, Portugal or Russia; these five countries are subsequently omitted from the study. For the other 13 countries we consider the number and nature of the incidents registered. For countries with an incident registration system, deliberate abuse and poisonings resulting from approved pesticide use are developed in further detail.

3.1 Incident registration in European countries

Six countries replied that incidents were not registered systematically in their country: Belgium, Poland, Ireland, Spain, Sweden and Switzerland. Belgium and Switzerland proved to have *ad hoc* data available on certain incidents and these were used to the extent that they were relevant for further analysis.

In seven countries incidents proved to be registered systematically. France, the UK, the Netherlands, Germany, Denmark, (northern) Greece and Norway. In all these countries institutes of the Ministry of Agriculture register incidents. Conservation and environmental organisations were rarely found to have data at their disposal.

There is considerable variation in the way incident registration is set up in the various countries. In France, for example, 72% of incidents involving vertebrates were reported by the hunting community, 12% by veterinary practitioners and laboratories, 8% by pet-owners and the remaining 8% by a variety of agents such as municipal authorities and humane societies (period 1994–1995; Berny, P, Ecole Nationale Veterinaire de Lyon, 1996, pers comm). In the UK, nearly all incidents were reported by private citizens (Fletcher, MR, CSL-MAFF, 1996, pers comm). In the Netherlands, 56% of pesticide incidents were reported by criminal investigation agencies (police and General Inspection Service, AID), 15% by private citizens, 13% by bird rehabilitation centres and bird-spotter groups, 12% by agencies managing forested and other lands (e.g. Forestry Commission, SBB) and 4% by water management agencies (period 1990–1994).[14] It is noteworthy that in 1993 and 1994 there were no reports by private citizens. In Germany, 66% of incidents were reported by staff of the Plant Protection Service, 23% by nature conservation organisations, 7% by the hunting community and 3% by the police (period 1988 to 1993; Joermann, G, BBA, 1996, pers comm).

The background of the party reporting the incident is influenced partly by who is to pay the cost of the (toxicological) investigation in the country in question. In France, about 70% of the cost of the investigation is paid by hunting associations and the remainder by conservation organisations (Berny, P, 1996, pers comm). In the UK, the Wildlife Incident Investigation Scheme is run by the government departments responsible for Agriculture, with most post-registration surveillance work being funded by the agrochemical industry by means of a levy on sales of products.[1] Until 1994 costs in the Netherlands were borne by the Institute for Animal Science and Health (ID-DLO), but they are now paid by the party reporting the incident, except in the case of a

Country	No. of incidents	Deliberate abuse (%)	Approved use (%)	Misuse (%)	Unknown (%)
France[a]	414	53	18	3	25
United Kingdom	384	66	10	5	18
Netherlands	221	56	6	1	38
Germany	14	21	21	14	43
Denmark	13	100	0	0	0
North Greece	11	46	0	36	18
Norway	6	100	0	0	0

Table 2. Causes of pesticide incidents (percentage), 1990–94

[a] Based on 1994 and 1995.

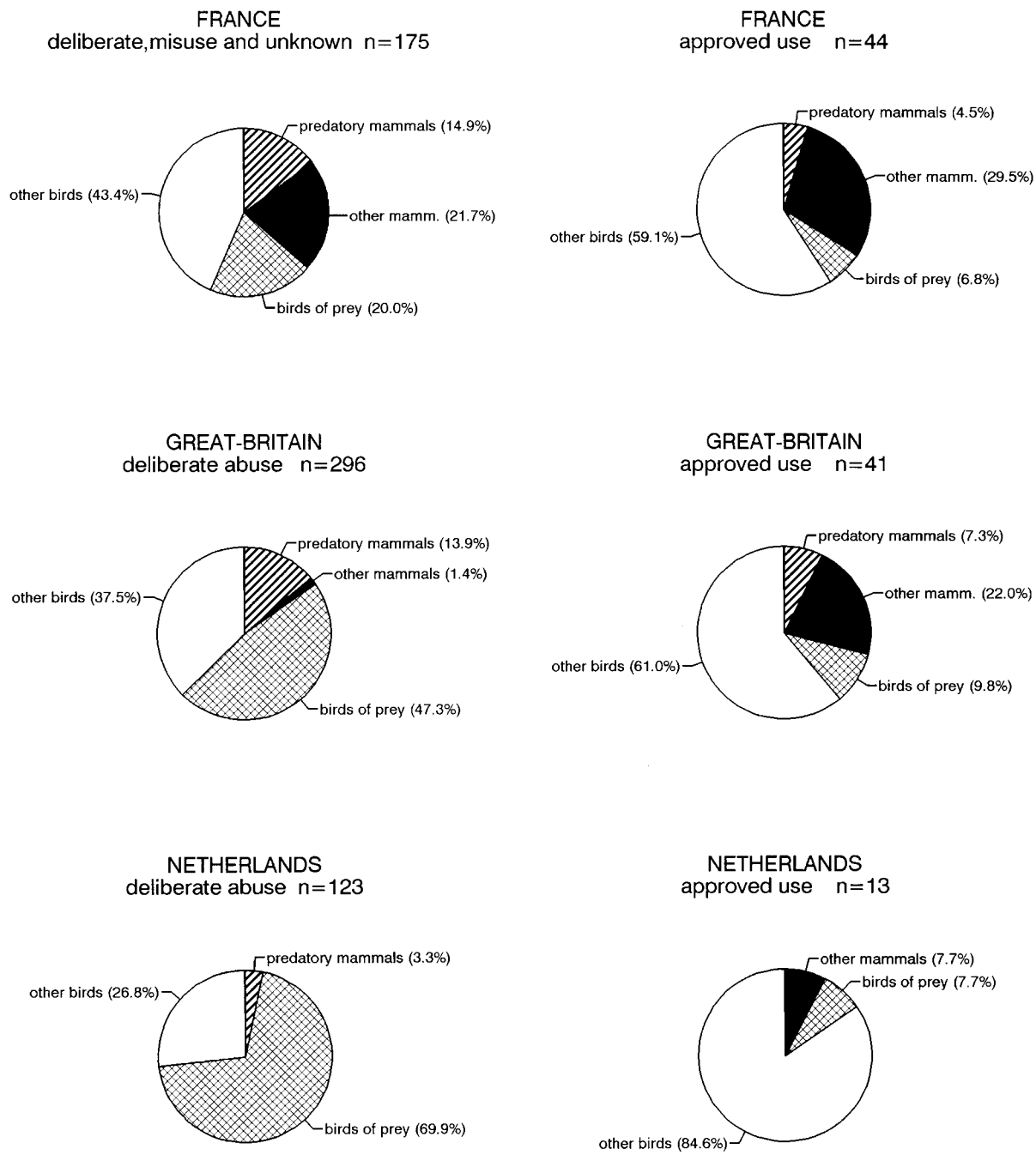

Figure 1. Incidents due to deliberate abuse and approved use in France, UK and Netherlands, by species group: birds of prey, other birds, predatory mammals and other animals. (NB: In France the cause of death was not established prior to 1994; it has been assumed that the distribution of causes in 1990–1993 was the same as that in 1994 and 1995. Also, total number of incidents may deviate from data in Tables 1 and 2 because animals from different categories may be involved in the same incident.)

criminal offence. In Germany, in general the costs are paid by the regional agricultural services.[15]

3.2 Number and background of incidents

For those countries with an incident registration system in place, Table 1 shows the number of pesticide incidents that occurred during the period 1990–1994, broken down into incidents involving birds, mammals and amphibians. As the table shows, there are major differences among the countries investigated. By far the majority of incidents are reported in France, the UK and the Netherlands. Few incidents are reported in Germany, Denmark, (northern) Greece or Norway and most of these involve birds. Only in France and the UK are incidents involving mammals reported regularly. Incidents with reptiles or amphibians are rarely if ever reported.

Table 2 reviews the causes of the incidents in the various countries, with a distinction being made between approved use, misuse, deliberate abuse, and incidents that could not be attributed to any particular cause. A comparison of the countries with the most frequent reported incident (France, UK, Netherlands) shows that the majority are due to deliberate abuse (53–66%). Compared with the Netherlands and France, the UK has a relatively

Table 3. Pesticides causing most incidents involving deliberate abuse in different European countries, 1990–1994

Pesticide group	France[a]	United Kingdom	Netherlands	Germany	Denmark	Norway
Rodenticides[b]						
Alphachloralose	36	149	12			
Strychnine	4	27	3			
Coumatetralyl		3				
Difenacoum		1				
Bromethalin		2				1
Others	4	1	1			
Insecticides						
Mevinphos	39	29	10	2		
Carbofuran	29	9				
Aldicarb	17	3	43[c]			
Fenthion		14				
Endrin		8				
Bendiocarb		4				
Malathion		4				
Parathion		1	51	1	11	4
Diazinon		1	1			1
Carbamates					2	
Others	15					
Herbicides						
Paraquat		3				
Molluscicides						
Metaldehyde		2				
Methiocarb		1				
Total[d]	143	262	121	3	13	6

[a] Data for France 1994–1995; Greek data could not be broken down.
[b] Including active ingredients (also) against other vertebrates (for example alphachoralose, strychnine and cyanide in the UK).
[c] Including eight incidents whereby poisoning with blue granulate was established, but without further toxicological investigation.
[d] Some abuse incidents involved more than one compound found in the poisoned wildlife.

high proportion of deliberate abuse. On average, approved pesticide use causes 6–18% of the incidents. In the Netherlands, particularly, very few incidents are reported that are due to approved pesticide use; however, there is a relatively high number of incidents (38%) that cannot be attributed to any specific cause. Finally, a small proportion of the incidents (<1–5%) is caused by pesticide misuse. The data from the countries with few incidents show that the majority of these incidents are due to deliberate abuse. Only in Germany is this a relatively minor cause; here, though, the majority of incidents cannot be ascribed to any one cause.

3.3 Deliberate abuse: species and substances

In Fig 1 the deliberate abuse reported in the UK, the Netherlands and France is broken down into incidents involving birds of prey (including owls), other birds and predatory and other mammals, although, in the case of France these figures are estimates, as statistics on incidents due to deliberate poisoning also include incidents due to misuse and unknown cause. As the figure shows, the majority of cases of deliberate abuse (63–98%) involve birds. In general terms, it can be concluded that two basic categories of poisoning are involved here. The first concerns the poisoning of birds of prey using bait. In all three countries, buzzards are the most common victims, followed at a distance by such species as goshawk and marsh-harrier (Netherlands) and red kite and peregrine falcon (UK). The second category involves seed-eating species being poisoned by treated seed. In this case, corvids, pheasants, pigeons and ducks are the commonest victims (particularly in the Netherlands and France). In these three countries, virtually all cases of mammal poisoning involved foxes and badgers. One incident involving frogs was reported. In Denmark, Germany, Belgium, Switzerland and Norway virtually all registered cases of deliberate abuse involved birds. In these latter countries, the most common victims were such species as black-headed gulls, ducks, geese, corvids and pigeons.

Table 3 breaks down the incidents in terms of the various categories of substance involved (rodenticides, insecticides and herbicides) and the individual active ingredients used in the case of deliberate abuse. It is found that rodenticides

Table 4. Number of incidents caused by approved pesticide use, and species involved, for United Kingdom, Netherlands (1990–1994) and France (1994–1995)

Mode of application/ingredient	*France*		*United Kingdom*		*Netherlands*	
Bait:		34%		17%		8%
Bromadiolone	7 roedeer, boar		4 rabbit, dunnock, fox		1 wild duck	
Difenacoum			2 barn owl, polecat			
Brodifacoum			1 fox			
Chlorophacinone	8 pigeon, hare, rabbit, eagle, hedgehog					
Slug pellets:		5%		7%		
Metaldehyde			3 pheasant			
Methiocarb	2 roedeer, rabbit					
Granules:		7%		10%		
Disulfoton			1 duck			
Carbofuran	3 partridge, birds of prey		3 buzzard, blackbird sparrow, pheasant			
Seed treatment:		50%		32%		23%
Fonofos			6 pheasant, pigeon		1 grey goose	
Chlorfenvinphos			4 pheasant, pigeon			
Bendiocarb			2 rook, duck			
Gamma-HCH			1 pigeon			
Methiocarb					1 starling	
Thiomethon					1 herring gull	
Imidacloprid	8 partridge, pigeon, duck					
Furatihocarb	14 pigeon					
Pour-on cattle/treatment animals:				10%		
Famphur			3 buzzard, magpie			
Bromocyclen			1 pigeon			
Spraying:		5%		24%		69%
–on grass:						
Chlordane (golf course)			1 tawny owl			
Triazophos			1 goose			
Paraquat (road verge)			1 hedgehog			
Parathion					6 goose, jackdaw, wigeon, wild duck	
–on crop:						
Paraquat			1 hare			
Monochloracetate			1 pigeon			
Mevinphos					1 sparrow	
–wood preservative treatment:						
HCH/Pentachlorophenol			1 bat			
HCH			1 bat			
Permethrin			2 bat			
Lindane						
Endosulfan					1 bat	
Aldrin	1 pigeon					
Dieldrin	1 pigeon					
–wasp nest treatment:						
Permethrin			1 bat			
–unknown:						
Parathion					1 buzzard	
Total	44		41		13	

(including active ingredients used against other vertebrates) and insecticides were responsible for 98–100% of such poisonings. In the UK, particularly, the use of pesticides against vertebrates for this purpose is fairly common (70%). Among the rodenticides, alphachloralose (in the UK also used to control some bird species) is most commonly employed, followed by strychnine (in the UK only used to control moles). Among the insecticides, mevinphos, parathion, aldicarb, carbofuran and fenthion are most frequently used. In Belgium, too, incidents involving parathion and aldicarb are reported from time to time (Houins, G, Ministry of Trade and Agriculture, 1995, pers comm).

3.4 Poisonings due to approved use: mode of application, substances and species

Table 4 shows the incidents occurring in France, the UK and the Netherlands as a result of approved pesticide use, broken down in terms of mode of application (baits, granules, seed treatment, etc). As can be seen from the table, most of the reported incidents were associated with the use of pesticide-treated seeds (23–50%), the laying of bait (8–34%) and liquid spraying (5–69%). In the case of incidents with treated seeds, the greatest mortality was in pigeons, pheasants, partridges and ducks. With baits, the main casualties were mammals such as the fox. Of all the incidents caused by approved use, 61–92% were due to insecticides. In France, a relatively high proportion of incidents was due to rodenticides.

If the incidents due to liquid spraying are broken down further, they are found to have been caused mainly by spraying of grassland vegetation and by spraying in or around buildings. In the first case, incidents are associated above all with control of crane-fly larvae with parathion in the Netherlands during the winter half of the year, with casualties occurring among various species of geese and ducks (including widgeon) and jackdaws. In the second case, the main cause is timber treatment, with bats the major victims.

One remarkable result is that, although by far the majority of pesticides are sprayed on crops, in the countries in question only a small number of incidents are known to be the result of routine crop-spraying operations. In the Netherlands, mortality among sparrows is known following mevinphos-spraying of Brussels sprouts. In the UK, one incident was reported among hares in a potato crop where paraquat had been used as a haulm desiccant and one incident among racing pigeons which were poisoned after feeding on grass which had been contaminated with spray drift (monochloroacetate) from a neighbouring field. Finally, a field application with parathion and the secondary poisoning of a buzzard *via* insects in the Netherlands may have been the result of crop-spraying.

In Germany, too, three incidents were registered in the period 1990–1994 that were the result of crop-spraying operations. Spraying with parathion in the spring season led to mortality among greylag geese after they had fed on winter cereal. Methomyl application to vegetable crops led to songbird mortality, probably as a result of their drinking from leaf axils following a period of summer drought. Finally, there was an incident involving spring-migrating frogs, which succumbed to poisoning after crossing a field of winter barley that had just been sprayed with propyzamide.[11] In Switzerland the Swiss Ornithological Station registered 93 birds of prey killed through carbofuran poisoning between 1980 and 1993, most of them due to secondary poisoning *via* contaminated earthworms.[4,10] In Denmark and Norway no incidents due to approved use were registered during the period under study.

3.5 Incidents of unknown origin

Compared with France and the United Kingdom, the Netherlands has a high percentage of incidents (38%) that cannot be attributed to any specific cause (approved use, misuse or deliberate abuse). A consideration of the substances and species involved shows, however, that all these incidents were caused by insecticides: in 60 cases parathion, seven aldicarb and seven mevinphos. These substances are also those most generally used in the case of deliberate abuse. It is found, moreover, that 90% of the casualties were birds of prey, particularly buzzards, with such mammalian predators as foxes among the remaining victims. With these species, few incidents are reported that are the result of approved pesticide use. It therefore seems likely that the majority of the incidents of unknown cause should be attributed to the category of deliberate abuse. Only the incidents involving herring gull, duck and possibly magpie may perhaps be due to approved pesticide use. It thus appears very probable that the percentage of deliberate abuse in the Netherlands is not 56% but closer to 90%! For other countries such as the UK this kind of extrapolation yields less unequivocal results. There, there was a substantial number of incidents of unknown origin involving active ingredients against vertebrates, for example. On the basis of the substances and animal remains found, however, it was not possible to ascertain whether or not deliberate abuse was involved: both options are possible.

4 DISCUSSION

4.1 Registered incidents: a true reflection of numbers of incidents?

As the survey results show, there is considerable variation in the design of the incident registration system in each country. In some countries registration is entirely lacking, while in others there is an extensive registration protocol in place, systematic follow-up investigation and regular publication of statistics and results. Registration is not standardised, at the EU level, for example. All that can

be said is that registration is frequently handled by institutes of national agriculture ministries.

There is also considerable variation in the numbers of incidents reported in the various European countries. An important question is whether these differences are due to differences in the actual frequencies of incidents, or to differences in registration systems, the nature of cadaver searchers/retrievers and how the costs of investigation are covered. Do France, the Netherlands and the UK, in other words, have a better incident registration system than such countries as Germany, Norway and Denmark? On the basis of the present study, no clear answer can be given to this question. In the case of Germany, for instance, where data are collected regionally, an incomplete overview may be maintained at the national level, while in other countries there may indeed be few incidents. The only conclusion is therefore that inter-country comparison is feasible to a limited degree only, and that any such comparison should be undertaken with great caution.

4.2 Comparison of incident data

Given the above, any comparison of these survey results must necessarily be broad. Based on the data provided by current incident registration systems, it can be stated that pesticide incidents involving terrestrial wildlife are still a common occurrence. The bulk of the incidents reported involved deliberate abuse; in particular of birds of prey such as buzzards, using poisoned bait. Birds-of-prey killing is probably carried out by huntsmen or gamekeepers to control predators with the aim of increasing stocks of game birds such as partridge. In addition, many seed-eating birds are killed, many of them after eating pesticide-treated seeds. It is assumed that farmers strew these treated seeds, with a view to reducing damage to newly planted crops.

With regard to the causes of incidents and the faunal groups and pesticides involved, the data from this study, covering the period 1990–1995, show a similar picture to those for previous periods. In the UK, deliberate abuse accounted for 61% of all reported incidents in the period 1964–1983 and for 65% in the period 1985–1987.[5,16] In this study the figure is again 66%. In the Netherlands, the percentage of deliberate abuse was 55% in the period 1975–1988, and 56% in the present study.[17] In the past, too, most of the casualties were birds of prey (particularly buzzards), corvids and pigeons; in the UK, the agents alphachloralose, strychnine and mevinphos were responsible for the largest number of incidents, while in the Netherlands this was parathion.[5,17]

It can therefore be concluded that when it comes to pesticide incidents involving terrestrial wildlife, essentially, little has changed over the past 35 or so years with regard to causes, substances and species. More than anything else, resolution of the problems outlined here requires a change of mentality on the part of the actors (farmers, huntsmen and gamekeepers) involved; in this context, governments and organisations of huntsmen, gamekeepers and farmers have a very important role to play.

Only a small fraction of incidents resulting from approved pesticide use are registered. Again, this supports past findings in such countries as the UK and the Netherlands.[5,16,17] Most incidents reported involve specific pesticide applications such as treatment of buildings, application of wood preservatives, grassland spraying and the seeding of fallow land. With all these applications, any casualties are readily visible, occurring as they do at regularly frequented sites (around buildings) or, alternatively, at outdoor locations where the absence or paucity of vegetation means that victims are conspicuous (seeded fields and grassland). The question is whether smaller, less conspicuous bird species, for example, would also be found between crop plants, or in field margins, which are less frequented.

The probability of bird deaths due to poisoning following approved pesticide use actually being reported to an incident investigation scheme is governed by several factors:[18] first, the probability of birds dying on or near the site of application (rapidity of onset of toxic effects and species mobility); second, the probability of cadavers being found (body size),[19] conspicuousness of plumage, number of birds dying, scavenger pressure, frequency of observers visiting the site; and, third, the probability of events being reported to the scheme (scale of mortality, conservation status of species involved, public awareness of registration scheme).

Based on the above, it can be queried, finally, how suitable incident registration is as an instrument for bringing to light the side-effects of pesticides used under approved conditions. Generally speaking, incident registration is a very selective surveillance instrument (type and intensity of registration scheme, type of searcher, type of incidents, applications and species reported, etc). It is also a reactive instrument. As a first step towards reducing these two limitations, an effort should be made to make the surveillance instrument less selective and at the same time more active in character. One possibility might be to respond to incidents that are probably associated with approved pesticide use by immediately setting up an intensive monitoring campaign, based on proactive, planned sampling from populations at risk.[20,21]

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